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Article

Influence Plowed Maize Stalks on the Dynamics of Microbial Indicators in Soil

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Abstract: If the incorporation of organic matter from treated plots microbiological preparations can be significantly affected by changes in the microbial community of mineralization significantly bulky organic matter. The aim of the study was to determine the basic parameters of soil biogenicity before sowing soybeans on the parcels where the corn was pre-sown under the following fertilization variants: 1. Mineral fertilizer 100 kg N / ha; 2. Corn stalks; 3. Corn stalks + 80 kgN / ha; 4. Corn stalks + 80 kgN / ha +20 lit / ha EM Aktiv. At the beginning of vegetation, microbial soil characteristics up to a depth of 0-20 cm were determined according to the number of different physiological and systemic groups of microorganisms The total number of microorganisms as well as the number of tested microorganism groups had the highest values in variant 4. Given that the synthesis of humus is a long slow process, it can be concluded that the cultivation of maize and the introduction of different groups of microorganisms can affect significant processes in the soil.

Keywords: maize; microorganisms; nitrogen

1. Introduction

Soil organic matter is very important for maintaining the stability of the overall ecosystem as well as for sustainable soil management (Wayne *et al*., 2019). The application of agro-technical measures on agricultural land significantly affects the quantitative changes of organic matter. According to Buckman and Brady, in the United States, organic matter levels have declined more than 30% in cultivated soils over many years. According Rusco *et al*., (2001), different forms of fertilizer and crop rotation having a significant influence on the contents of carbon and nitrogen in the soil. Increasing organic matter levels can increase plant nutrient content (Delgado and Follett 2002), increase element mobility, and increase water content (Rawl *et al*. 2003). Organic carbon content and its reserve can be preserved through the application of organic fertilizer, by plowing the harvest residues. The mass of harvested residues depends on the plant species, but in any case it is large (corn 12 tha-1, wheat 4-6 tha-1, sunflower 4-5 tha-1, soybean about 4 tha-1, and in sugar beet as much as 40 - 60tha^{-1}) (https://www.researchgate.net/publication/). In the harvest residues, the highest carbon content is (45%). According to Kastora and Tesic (2006), there are about 57% of carbon in maize, which is significant considering the amount of biomass. Plowed harvesting residues fall under the life activity of micro-organisms, with the separation of low-molecular-weight and collagenous compounds that plants can absorb and engage in the transport of matter and energy. Given the high percentage of carbon in the harvest residues, their mineralization is slow. However, if it is in front of crop remains introduce fertilizers prevents a change of the variety of biodiversity that can occur in the disorder of the relationship of C / N. If a different group of heterotrophic microorganisms is introduced into the tillage of the harvesting residues, the mineralization processes can be impeded as their abundance, diversity and enzymatic activity in the soil increase.

Information on general microbial activity and potential soil fertility can be obtained by continuous monitoring of microbiological activity through determination by systematic and physiological groups of microorganisms, species and genera, as well as general enzymatic activity (Milošević *et al*. 2006).

The aim of study is set to determine the pace of activity characteristic groups of microorganisms in the soil after maize straw and different combinations of fertilizers.

2. Materials and Methods

The experiment was carried out in the lower Srem on the plot where in the autumn the harvested corn remains were hybrid ZP 684. The hybrid used has a stem height of up to 270 cm, belongs to the group of yellow-toothed teeth, with a mass of 1000 grains up to 390 g. The experiment is set on a plot of 33, 46 m2 in total. The parcel is divided into 4 sub parcels according to the number of treatment variants. The corn is chopped and plowed in basic tillage to a depth of 25-30 cm. Mineral NPK (10:30:20) fertilizer was introduced and 46% N pre-sowed. A microbiological preparation with a large group of effective micro-organisms EM was applied by spraying chopped corn on a parcel in the amount of 20 l / ha and 10 days before sowing soy in the same amount. F1 Mineral fertilizer control 100 kg N / ha; F2 Corn stalks; F3 Corn stalks + 80 kgN / ha; F4 Corn stalks + 80 kgN / ha +40 lit / ha EM Aktiv (trade name). At the beginning of soybean vegetation, microbial soil characteristics were determined up to a depth of 0-20 cm. The microbial abundance was determined by the plate agar method on selective nutrient medium, from prepared dilution series dilutions of 10 g of soil. The total number of microorganisms was determined on an agarized soil extract from dilution 107. The number of ammoniators was determined from dilution 106 on meat peptone agar (Pochon and Tardieux 1962). The number of phosphomobilizers was determined from dilution 105 on a glucose-asparagine substrate according to Muramtsov (Govedarica, Jarak 1993), while the number of phosphomineralizers was determined on the basis of Menkine (Rodine1965) from the same dilution.

3. Results

The diversity and abundance of soil microorganisms far exceeds the diversity of organisms in other ecosystems. In terms of species, the diversity of microorganisms accounts for about 25% of global biodiversity (Decaëns 2010; Coleman *et al*. 2015). Soil microorganisms are an inseparable determinant of soil, because by their composition and activities they significantly influence the processes that are important for maintaining soil fertility.

Biological and activity of microbial population in the soil depends on the applied type and amount of fertilizer and herbicide (Milošević *et al*., 2005; Cvijanović *et al*., 2006; 2011) Considering that the microorganisms are living things that have its own dynamics occur numerous obstacles which hinder an appointment of biodiversity in the land.

In determining soil biological activity, the total number of microorganisms can be taken as a very good indicator. Bacteria, especially diazotrophs from the family *Azotobacteraceae* and *Enterobacteraceae* (Wayne *et al*., 1977; Rennei, 1981), are most prevalent in the total number of microorganisms, followed by the genera Bacillus (Nelson et al., 1976), *Azospirillum sp., Pseudomonas sp.* (Juhnke *et al*., 1989). They are thought to have the greatest impact on the physiology of the plant Antoun and Kloepper, (2001). Djukic *et al* (2014) state that the application of microbial fertilizers and the plowing of plant residues can provide high soybean yields, even at reduced doses of nitrogen fertilizers applied in the previous crop.

Based on the obtained studies (Table 1), the dynamics of the total number of bacteria is clearly expressed. The increase in the total number of microorganisms depending on fertilization was from 21.51% (F1) to 84.15% (F4). The increase in abundance was at the level of statistical significance of $p < 0.01$. Aminohetrotrophs are a large group of bacteria and fungi that transform proteins and other nitrogen compounds in the process of ammonification, thereby releasing ammonia. Because of the end products (ammonia) with the transformation, the process of ammonification is especially important in the process of humification. Number of this group of microorganisms was increased from 40.15% to 117.13% (p <0.01).

Table 1. Number of microorganisms (CFU ml-1 g-1 absolutely dry soil)

Microbial group	Fertilizer				Statistical significance		
	1	2	3	4	F test	LSD <0.05	LSD <0.01
Total number of microorganisms	299,8	364,3	448,3	552,1	71,80**	41,54	60,44
Index lavel	100	121,51	149,53	184,15	CV % = 5,27		
Abundance of aminoheterotrophs	18,38	25,76	33,46	39,91	73,80**	3,54	5,515
Index lavel	100	140,15	182,04	217,13	CV % = 6,41		

One of the significant determinants of soil fertility is its ability to supply plants with the required amounts of phosphorus. Unlike nitrogen, phosphorus is a poorly mobile element in the soil-plant system. Soil microorganisms play a significant role in the transformation of organic phosphorus compounds. Plants and microorganisms are competitors for small amounts of orthophosphorus ion whose concentration in soil solution is low and depends on the deposition, adsorption and immobilization reactions. The released orthophosphorus ion by the microorganisms is incorporated into the protoplasm of the microorganisms. After extinction, it comes into the soil as a microbial mass. The transformation of organic and inorganic phosphorus compounds in soil involves different groups of microorganisms having specific ferment systems (*Bacillus, Arthrobacter, Proteus, Serratia, Streptomyces, Aspergillus; Rhizopis*, etc.). The nutrition of plants with phosphorus, the concentration of the total biomass of the microorganisms, depends significantly on the dynamics of immobilization / mineralization of the phosphorus compounds. According to Chauhan et al (1981), these processes take place very quickly when a carbon source (cellulose in harvest residues) and nitrogen are added to the soil.

This group of microorganisms are referred to as Phosphorus Solubilizing Microorganisms (PSM). (Bhattacharyya and Jha, 2012) Microorganisms have a significant role in photomobilizers in the dissolution of phosphate-poorly soluble salts. Soil microorganisms *Pseudomonas, Mycobacterium, Micrococcus, Flavobacterium, Aspergillus, Penicillium soluble phosphates* Ca, *fluoroapatite, apatite*. Bactrie *Bacillus megaterium, Bac. subtilis, Bac. circulans* dissolve inorganic phosphorus forms by directly extracting P or Ca from the compound. The organic fraction of phosphorous compounds consists mainly of phytin, phospholipids, nucleic acids and their derivatives. Microorganisms play a significant role in the mineralization of organic compounds (*Bacillus, Proteus, Serratia, Aspergillus, Rhizopus, Penicillium, Trichoderma*). The number of phosphomobilizers was statistically highly significant at F 2 (251.39) and F3 (261.99) compared to the F1 (135.98) control. The increase in numbers ranged from 54.87% to 92.37%. The smallest increase was found in variant F4 (145,34) 6.88%. The dynamics of change in the number of phosphomineralizers was highly significant in all fertilizers compared to the control (p <0.01). The increase in numbers ranged from 42.33% (F1) to 70.05% (F4). The highest number was in F4 (259.04) which is also the highest percentage increase of 70, 05%.

Table 2. Microorganisms from the phosphorus cycle

Microbial group	**Fertilizer (F)**				**Statistical significance**		
	1	2	3	4	F test	LSD <0.05	LSD <0.01
Fosfomobilizator	135,98	251,39	261,99	145,34	224,61	14,63	21,29
Index lavel	100	184,87	192,37	106,88	CV % = 3,91		
Fosfomineralizatori	152,33	217,12	241,53	259,04	143,56	11,91	17,33
Index lavel	100	142,53	152,55	170,05	CV % = 3,29		

4. Discussion

According to the results of the research, the combination of corn plowing and the use of inoculants with effective microorganisms influenced the greatest intensity in changing the number of microorganism groups studied. Effective microorganisms are a mixture of cultures of beneficial microorganisms that can be found in nature. These include: photosynthetic bacteria milk bacteria, actinomycetes and fungi. These groups of microorganisms produce organic plant growth promoters, (Ranjith et al, 2007) and may also be substrates for bacteria and to increase microbial diversity, which is likely to have happened. Adding photosynthetic bacteria to the soil increases the content of other effective microorganisms e.g. mycorrhizal fungi. Bioactive substances produced by various yeasts (hormones and enzymes) promote cell division (Higa, 2000) and increase plant growth. Also, their secretions are useful substrates for effective microorganisms (milk bacteria and actinomycetes). The introduction and development of fungi in soil stimulate the processes of decomposition of harvest residues that are rich in carbon compounds and difficult to decompose. The use of effective micro-organisms is based on the principles of natural ecosystems that are maintained through their factors. They provide a small contribution to the application of these principles to natural systems such as agricultural land and to altering the microbial balance in favor of increased growth, production and protection of plants (Higa, 1994). According to Xu (2000) the combination of effective microorganisms and organic fertilizers promotes the growth and activity of the roots of the plants, which increases the grain yield. This is compounded by the increased availability of nutrients provided by beneficial microorganisms over time.

The results obtained are compatible with the results of Ferreira et al. (2012) who found that the bacterial community was enlarged by the ingestion of different organic matter. Thus, the diversity of the microbial community in soybean rhizoplane was found to increase by 12% by the introduction of organic matter, and by the introduction of green organic matter the grass (mulch) microbial community increased by 19%.

5. Conclusions

Based on the results obtained, it can be concluded that the plowing of harvest residues is a measure that can stimulate the activity of significant groups of soil microorganisms. The use of different groups of micro-organisms has enormous potential in the production of value-added food. Increasing groups of nitrogen-releasing microorganisms from porgan compounds can reduce mineral nitrogen fertilizers. The development of microorganisms that participate in the release of phosphorus ions has the potential for better plant productivity.

Therefore, the use of effective microorganisms in the production of health food and preserving soil fertility potential is the focus of the 21st Century in agriculture.

Inoculation of seeds / crops / soil by phosphate-dissolving microorganisms is a promising strategy to improve global food production without causing environmental hazards

This review has shown that phosphate-soluble microorganisms have enormous potential as bio-fertilizers. Mobilizing inorganic phosphate in the soil and increasing its bioavailability for use in the plant through the use of PSM soil promotes sustainable agriculture, improves soil fertility, and thus increases crop productivity. The use of PSMs as microbial inoculants is a new horizon for better plant productivity. PSM technology can contribute to low input agricultural systems and a cleaner environment. However, region-specific PSB technologies need to be developed and this should be communicated to farmers in a relatively short time

The focus of consumers of agricultural products is on the health, quality and nutritional value of these products. Therefore, using PSM as a bio-fertilizer is an option that can increase food production without imposing any health hazards while preserving the environment

The conclusion should present a clear and concise review of experiments and results obtained, with possible reference to the enclosures.

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References

Antoun, H., Kloepper, J. W. (2001): Plant growth-promoting rhizobacteria (PGPR), in: Encyclopedia of Genetics. Brenner, S. and Miller, J.H., eds., Academic Press, N.Y., 1477-1480.

Charyya P. N., Jha D. K. (2012). Plant growth-promoting rhizobacteria (PGPR): emergence in agriculture. *World J. Microbiol. Biotechnol.* 28 1327–1350. 10.1007/s11274-011-0979-9

Coleman D.C., Wall D.H. (2015): Soil fauna: occurrence, biodiversity, and roles in ecosystem function. In: Paul EA (ed) Soil Microbiology, Ecology and Biochemistry, 4th edn. Academic, Boston, pp. 111–149.

Cvijanovic Gorica, Dozet Gordana, Djukic Vojin , Subić Jonel, Cvijanovic Drago (2011): Effects of Nitrogen fertilising on the proceding crop and the application of Co and Mo on *Azotobacter* abudance in soya bean, Romanian Biotehnological, , 16, 1, 74-80

Cvijanović G., Milošević N., Lalević B. (2006): The changes of soil biogenity parameters after herbicide treatment. *Plant Science*, Vol. XLIII, No 6, Nat. Centre for Agr. Sciences, Sofia, Bulgaria, 558-561

Decaëns T. (2010): Macroecological patterns in soil communities. Global Ecol Biogeogr 19: 287–302

Delgado, J.A., and R.F. Follett. (2002) Carbon and nutrient cycles. J. Soil Water Conserv. 57:455–464.

Govedarica M., Jarak M. (1993). Praktikum iz mikrobiologije Poljoprivredni fakultetr Novi Sad

Higa T., Parr J. (1994). Beneficial and Effective microorganisms for a sustainable agriculture and environment. International Nature Farming Research Center Atami, Japan

Đukić V., Balešević-Tubić S., Miladinov Z., Dozet G., Cvijanović G., Đorđević V., Cvijanović M. (2014): Proizvodnja soje i mogućnost ekonomične upotrebe mineralnih đubriva Ratarstvo I povrtarstvo 2014, 51, 3, 161-165

Higa T. (2000). What is EM technology? EM World J 1:1–6

M., Jarak M. (1993) Praktikum iz mikrobiologije Poljoprivredni fakultetr Novi Sad

Milošević Nada, Jarak Mirjana, Milić, Vera, Mrkovački, Nastasija (2006): Mikrobiločka istraživanja od teorijskih osnova do preparata (1966-2005). Zbornik radova, Sveska 42, 327-337

Rodina M. (1965): metodi vodnoi mikrobiologii Nauka Moskva

Milošević N., Cvijanović G., Tintor *B*. (2005): Uticaj alahlora na mikrobiološku aktivnost zemljišta pod kukuruzom i sojom, Sedmo savetovanje o zaštiti bilja Zbornik rezimea, Soko Banja, 15-18.11.2005. godine. 146-147

Kastori, R., Tešić, M. 2006. Ekološki aspekti primene žetvenih ostataka njivskih biljaka kao alternativnog goriva, Zbornik radova, Institut za ratarstvo i povrtarstvo, Novi Sad, 42: 3-13.

Jones D.L., Nguyen C., Finlay R.D. (2009): Carbon flow in the rhizosphere: carbon trading at the soil-root interface. Plant Soil 321: 5–33.

Pochon J, Tardieux P (1962*): Techniques d'analyse en microbiologie du sol. Paris*, France.

Ranjith N.K., Sasikala C., Ramana C.V. (2007): Catabolism of l-phenylalanine and l-tyrosine by Rhodobacter sphaeroides OU5 occurs through 3, 4- dihydroxyphenylalanine. Res. Microbiol. 158, 506–511.

Rawls, W.J., Y.A. Pachepsky, J.C. Ritchie, T.M. Sobecki, and H. Bloodworth (2003): Effect of soil organic carbon on soil water retention. Geoderma 116: doi:10.1016/S0016-7061(03)00094-6 61–76

R. R., Wayne P. R., Deanna L. O. Joshua L. H., (2019): Comparing Four Methods of Measuring Soil Organic Matter in North Carolina Soils, Soil Sci. Soc. Am. J. 83:466–474 Comparing four methods of measuring soil organic matter in north carolina soils

Xu H.L. (2000). Effects of a microbial inoculant and organic fertilizers on the growth, photosynthesis and yield f sweet corn. J. Crop Prod. 3, 183–214.